57th Annual PAPA Conference

Hershey, Pennsylvania

NCAT Asphalt Research Update

Dr. Randy West, P.E.

Director / Research Professor

National Center for Asphalt Technology

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NCAT's mission is to provide innovative, relevant and implementable research, technology development and education that advances safe, durable and sustainable asphalt pavements.





Outline

- Pavement Economics Committee projects
  - Limiting strain in pavement design
  - Educational program
  - Thinlays
  - IRI related to performance
- Update on the NCAT Test Track
  - MnROAD partnership
    - performance testing for mix design and QC
    - pavement preservation

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Pavement Economics Committee Projects

- Optimized Pavement Design
- Determining Service Lives Based on IRI
- Thinlay Pavement Preservation Guide
- Educational Program
- Best Practices for Determining the Life Cycle Costs of Asphalt Pavements
- Life Cycle Benefits of Premium Mixes

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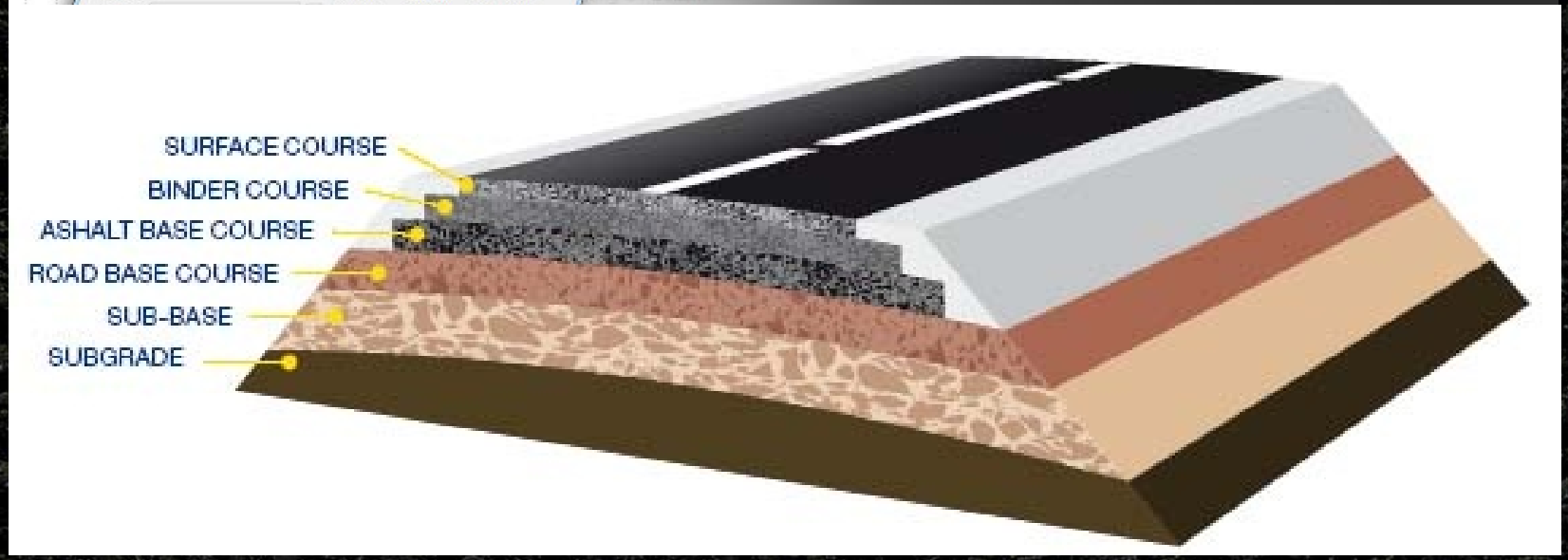
Pavement Engineering



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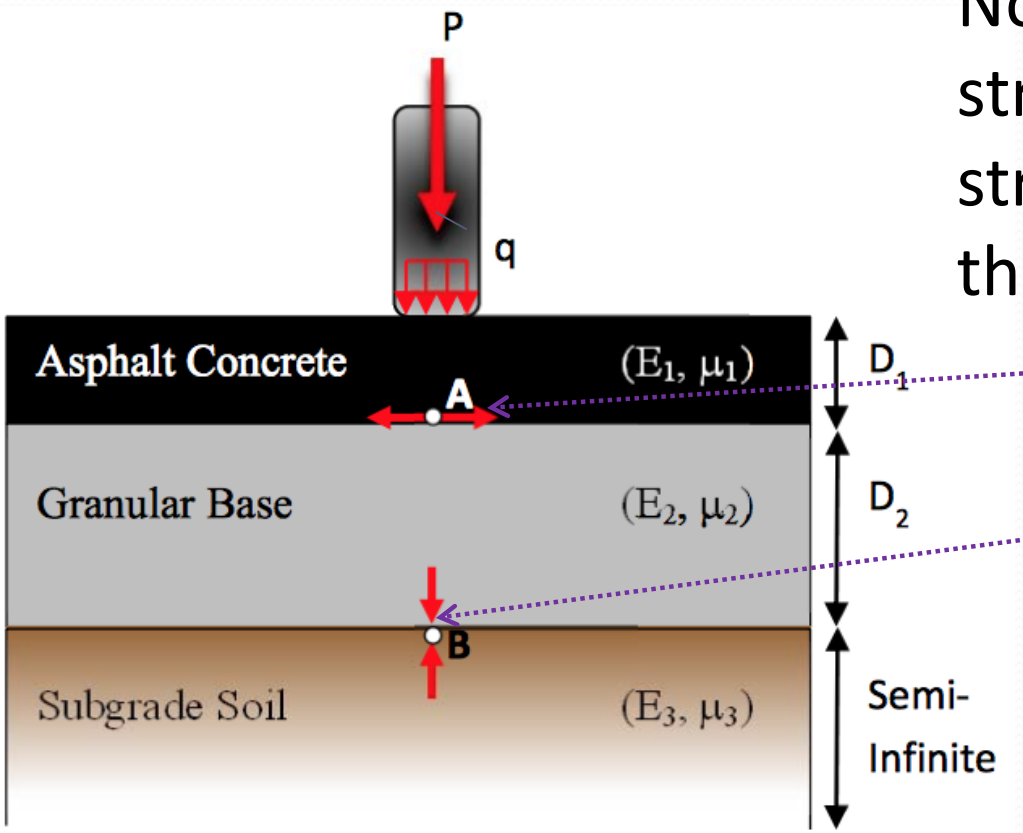
Concept of Perpetual Pavement



No fatigue cracking or structural rutting if critical strains are kept below thresholds

- Horizontal strains at bottom of AC layer
- Vertical strains at top of subgrade

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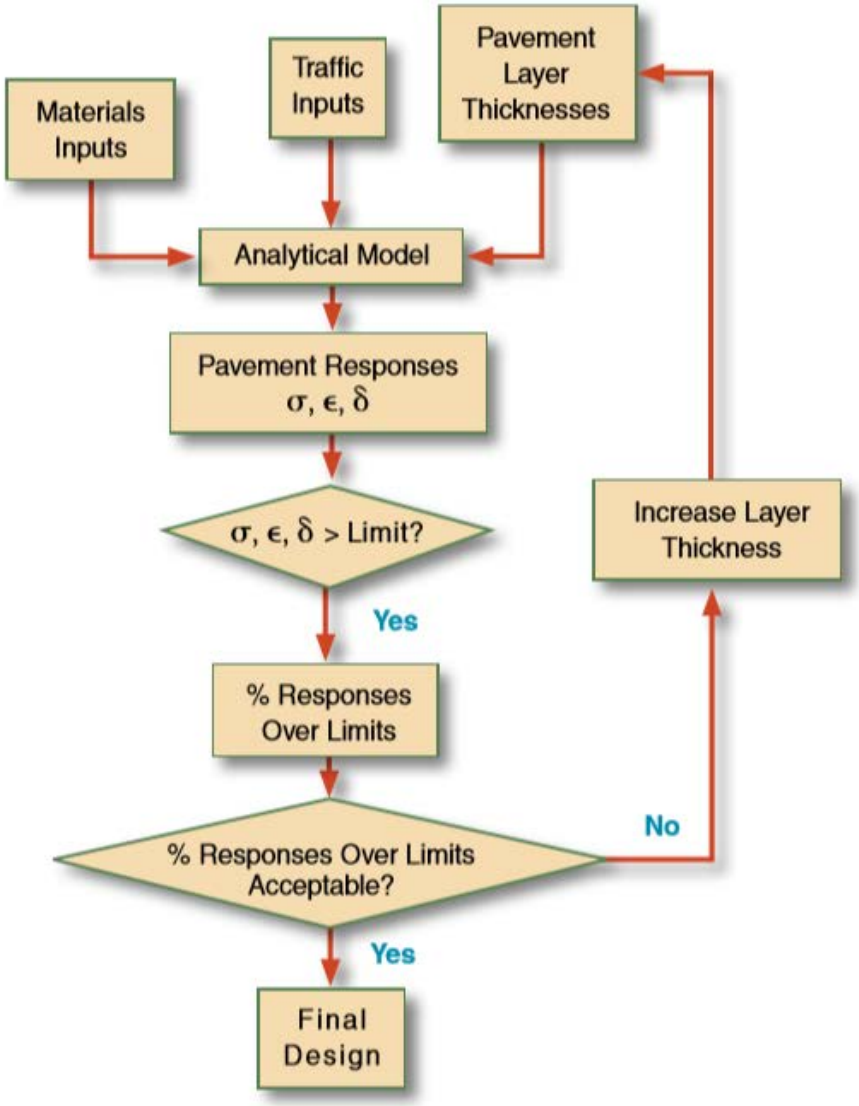
Perpetual Pavement Design



- For controlling bottom-up fatigue cracking
  - Calculated strain should be lower than the 60th percentile horizontal strain distribution
- For controlling structural rutting
  - Vertical strains at the 50th percentile should be lower than 200 microstrain

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Criteria validated with data from the NCAT Test Track and Perpetual Pavement Award sections

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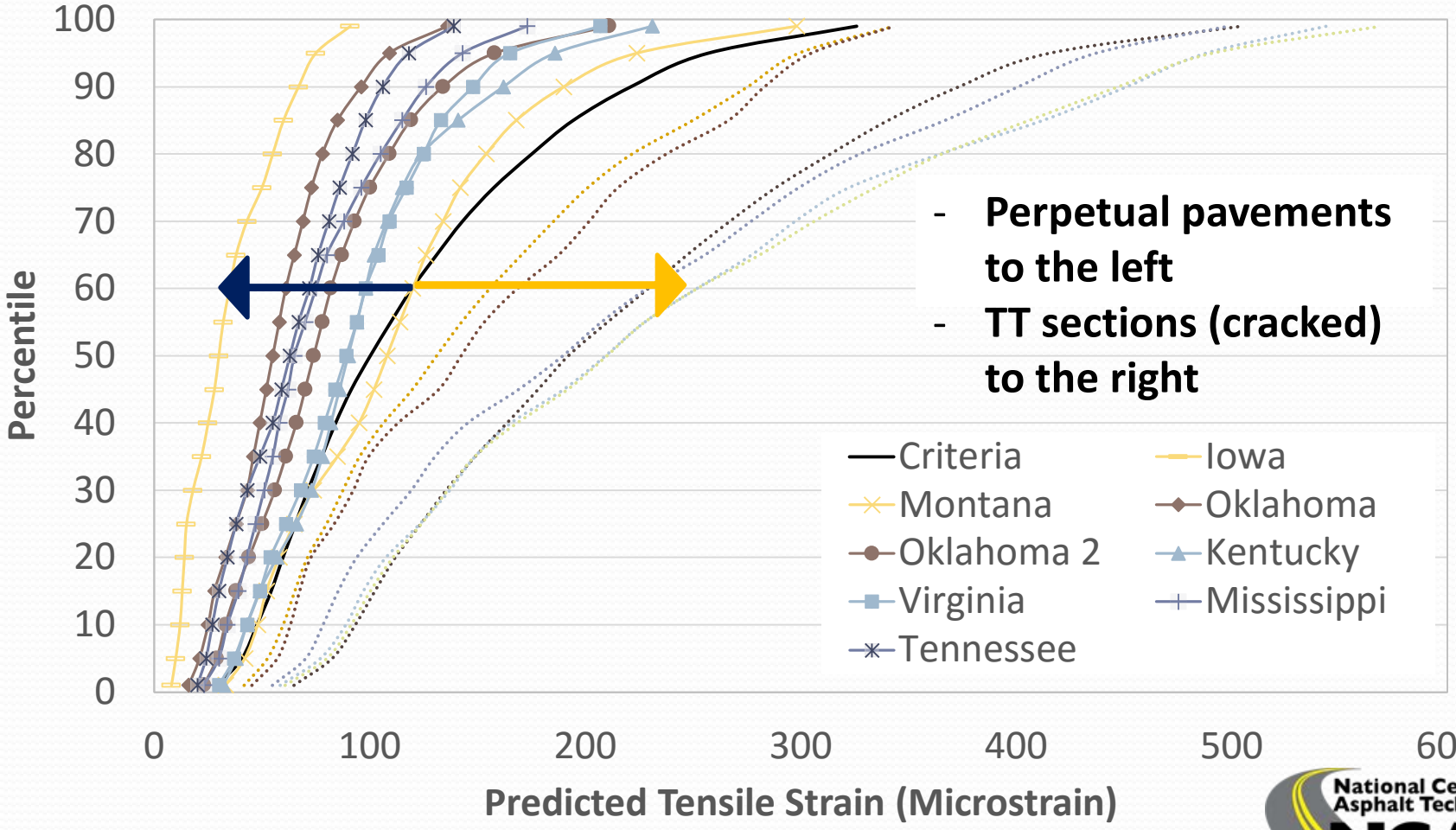
Validation of Horizontal Strain Distribution Criteria



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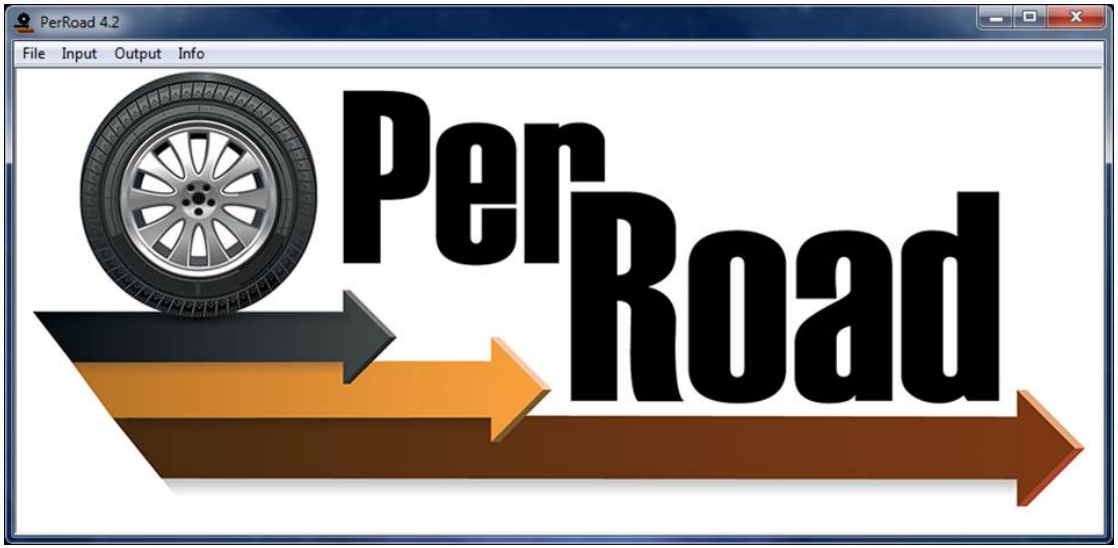
Validation of Vertical Strain Criteria

Pavement	Strain at 50th Percentile
Iowa	76 microstrain
Montana	146 microstrain
Oklahoma	128 microstrain
Oklahoma 2	153 microstrain
Virginia	169 microstrain
Kentucky	188 microstrain
Mississippi	164 microstrain
Tennessee	162 microstrain

Vertical strains at the 50th percentile for perpetual pavements are lower than 200 microstrain

Implementation of Limiting Strain Criteria



by Dr. David Timm, Auburn Professor of Civil Engineering

- PerRoad is being updated to include these limiting strain criteria

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Implementation of Limiting Strain Criteria

- References
  - NCAT report 15-05R: Refined Limiting Strain Criteria and Approximate Ranges of Maximum Thicknesses for Designing Long-Life Asphalt Pavements
  - NCAT Research Synopsis 15-05R
  - TRB Paper 17-02109

Set maximum AC thicknesses for flexible pavement designs


THINLAY
SAFE. SMOOTH. DURABLE.

Why Thin Asphalt Overlays?

- Shift to preservation and renewal
- Safety and smoothness are needed more than added structure
- Material improvements such as PMA, better aggregate specs, and mix type options.

Benefits of Thin Asphalt Overlays

- Long life and low life-cycle cost!
- Safety / User satisfaction
  - –Minimize traffic delays
  - –Smooth surface
  - –Restore skid resistance
  - –No loose stones & minimizes dust
  - –Lower noise
- Structural
  - –Maintain grade & slope
  - –Withstands heavy traffic
  - –Easy to maintain
- Sustainable
  - –Recycled materials
  - –Seals surface & no binder run-off

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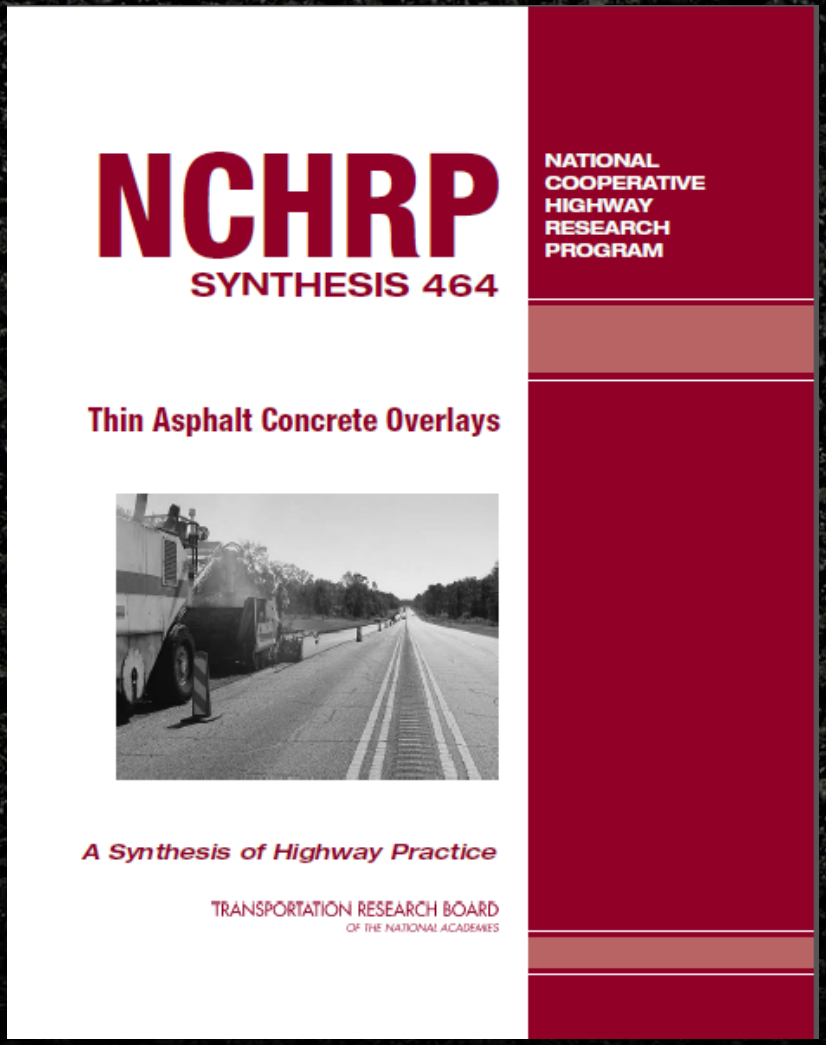
Thin Overlay Guides



- NCHRP Synthesis 464
- *Thinlays for Pavement Preservation* – pending publication from NAPA
- Future FHWA Tech Brief: *The Use of Thin Asphalt Concrete Overlays for Pavement Preservation*

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International Roughness Index (IRI)

- The only universal measure of pavement performance
  - All states required to report IRI in HPMS
  - The only common measure among all pavement types: asphalt, concrete, composite, other

International Roughness Index Categories

IRI Categories	Interstate Routes	NHS Non-Interstate Routes	Non-NHS Routes with ADT ≥ 2000	Non-NHS Routes with ADT < 2000
≤ 70	Excellent	Excellent	Excellent	Excellent
71-75	Good			
76-100		Good		
101-120	Fair		Good	
121-150		Fair		Good
151-170	Poor		Fair	
171-195		Poor		Fair
196-220			Poor	
> 220				Poor

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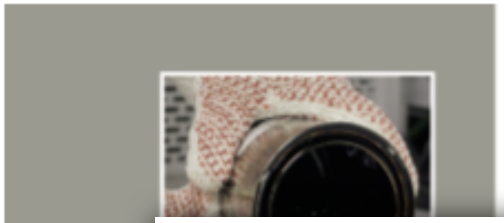
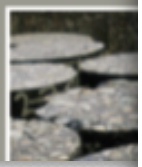
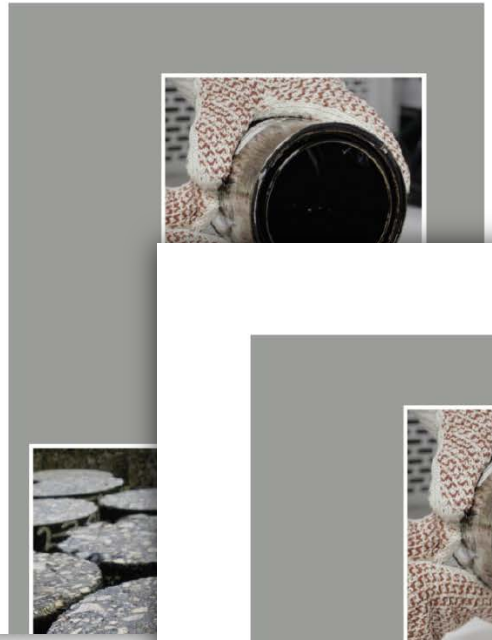


NCAT Report 15-02

LITERATURE REVIEW: THE IMPACT OF PAVEMENT ROUGHNESS ON VEHICLE OPERATING COSTS





NCAT Report 16-03

A SYNTHESIS REPORT: VALUE OF PAVEMENT SMOOTHNESS AND RIDE QUALITY TO ROADWAY USERS AND THE IMPACT OF PAVEMENT ROUGHNESS ON VEHICLE OPERATING COSTS

NCAT Draft Report

REVIEW OF INITIAL SERVICE LIFE DETERMINATION IN LCCA PROCEDURES AND IN PRACTICE

By

Dr. Mary M. Robbins

Dr. Nam H. Tran, P.E.

NCAT Report 16-03

1. INTRODUCTION
   - 1.1 Background
2. RIDE QUALITY AND PAVEMENT ROUGHNESS
   - 2.1 Importance of Ride Quality to Traveling Public
   - 2.2 Factors Related to Perceived Ride Quality
3. IMPACT OF PAVEMENT ROUGHNESS ON VEHICLE OPERATING COSTS
   - 3.1 Fuel Consumption
   - 3.2 Tire Wear
   - 3.3 Maintenance and Repair
   - 3.4 Oil Consumption
   - 3.5 Depreciation
4. SUMMARY
5. REFERENCES

"not only do our customers want smooth roads for comfort, smooth roads cost less for both the owner/agency and the user"
Mark Swandlund, FHWA

LCCA for Pavement Type Selection

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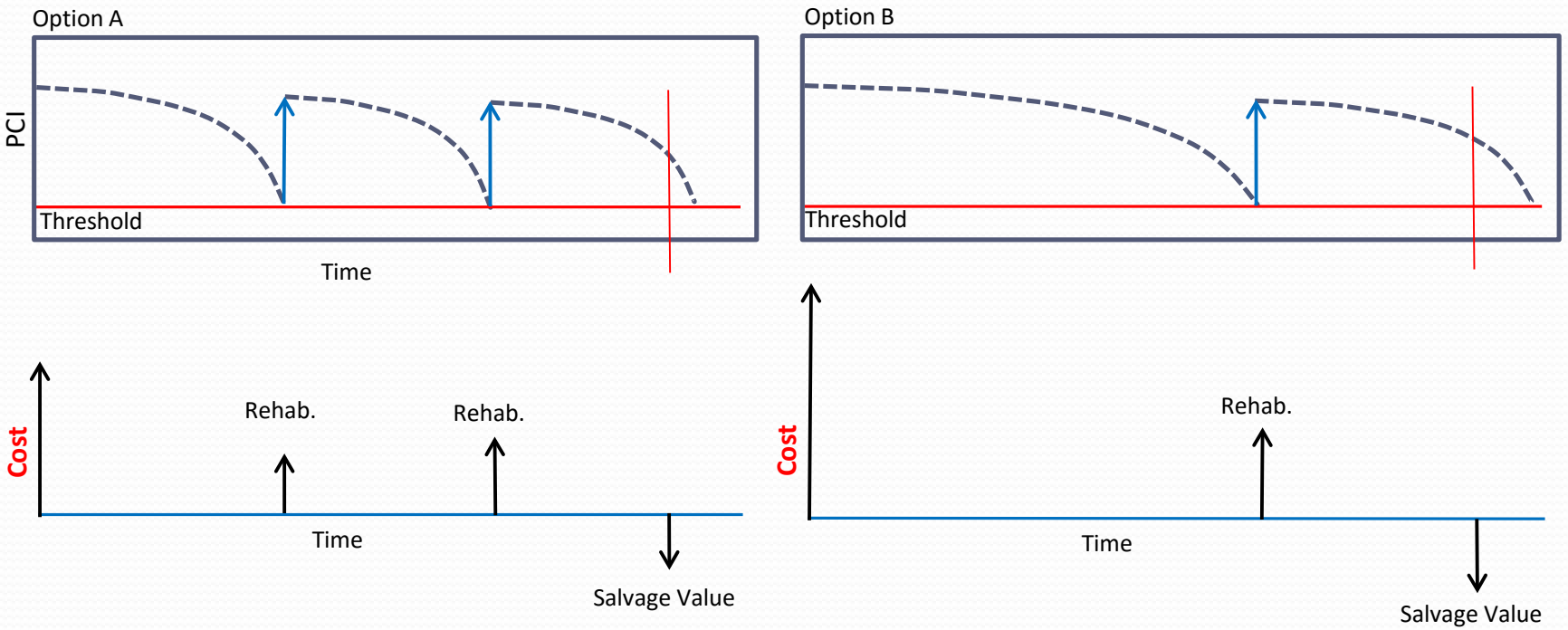
LCCA Basics



$$NPV = Initial\ Const.Cost + \sum_{k=1}^{N} Future\ \ Cost_k \left[\frac{1}{(1+i)^{n_k}}\right] - Salvage\ Value \left[\frac{1}{(1+i)^{n_e}}\right]$$

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Based on LTPP Data Pavement Age and Roughness at First Rehabilitation

Pavement Type	No.	Pavement Age at Rehabilitation (yrs)	Mean IRI prior to Rehabilitation (in/mi)
Asphalt	106	17.9	118.5
Concrete	44	24.0	146.5

Time to First Rehabilitation (Years) by Climatic Zone

	Asphalt Pavements					
Climatic Zone	No.	Avg.	Min.	Max.	Std. Dev.	COV
Dry, Freeze	24	15.0	7.1	26.3	5.1	34.0%
Dry, Non-freeze	23	19.7	7.8	27.0	4.6	23.5%
Wet, Freeze	50	20.0	8.8	28.2	5.5	27.3%
Wet, Non-freeze	109	16.8	7.8	28.9	5.3	31.8%
	Concrete Pavements					
Climatic Zone	No.	Avg	Min	Max	Std. Dev.	COV
Dry, Freeze	10	23.8	15.8	31.3	5.8	28.4%
Dry, Non-freeze	6	24.5	17.1	30.3	5.8	23.7%
Wet, Freeze	80	23.5	14.7	35.4	5.8	24.7%
Wet, Non-freeze	25	24.9	12.9	33.7	6.0	24.0%

IRI at First Rehabilitation by Climatic Zone

Climatic Zone	No.	Avg IRI (in/mi)	Min IRI (in/mi)	Max IRI (in/mi)	Std. Dev.	COV
	Asphalt Pavements					
Dry, Freeze	21	116	47	214	40	34%
Dry, Non-freeze	20	82	47	137	24	30%
Wet, Freeze	39	140	60	359	73	52%
Wet, Non-freeze	86	106	30	260	47	44%
	PCC Pavements					
Dry, Freeze	9	117	73	228	47	40%
Dry, Non-freeze	6	102	75	154	30	29%
Wet, Freeze	56	138	48	261	46	33%
Wet, Non-freeze	19	114	65	258	45	40%

Educational Program

- Life Cycle Cost Analysis for Pavement Type Selection
- Warm Mix Asphalt
- Open-Graded Friction Courses
- Using Recycled Materials
- Thin Overlays
- Perpetual Pavement Design

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Pavement Test Track

Asphalt Pavement Proving Ground

- 46 Test Sections, 200 ft. each
- Test sections are typically evaluated over a three year period
- 5 trucks each pulling 3 heavily loaded trailers make 400 laps/day

Types of Experiments

1. Structural expmts.
   - pavement design
     - Perpetual Pavement
     - MEPDG models
     - Empirical – layer coef.
   - contribution of non-traditional layers
     - highly modified mixes
     - OGFC
     - recycled bases
     - stabilized subbase
2. Surface expmts.
   - rutting
   - friction
   - permeability
   - noise
   - albedo
   - durability (raveling)
   - top-down cracking

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Refining Aggregate Specifications

- Eliminated the Restricted Zone
- Identify polishing prone aggregates
- Gravel works in SMA & OGFC
- Relax F&E limit for SMA & OGFC

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Findings Related to Mix Design

- Fine and coarse Superpave mixes perform similarly
- Modified binders reduce rutting approximately 50%
- Dense-graded mixes perform as well as SMA for rutting resistance, but SMA is more durable
- Lowering Ndesign does not lead to rutting

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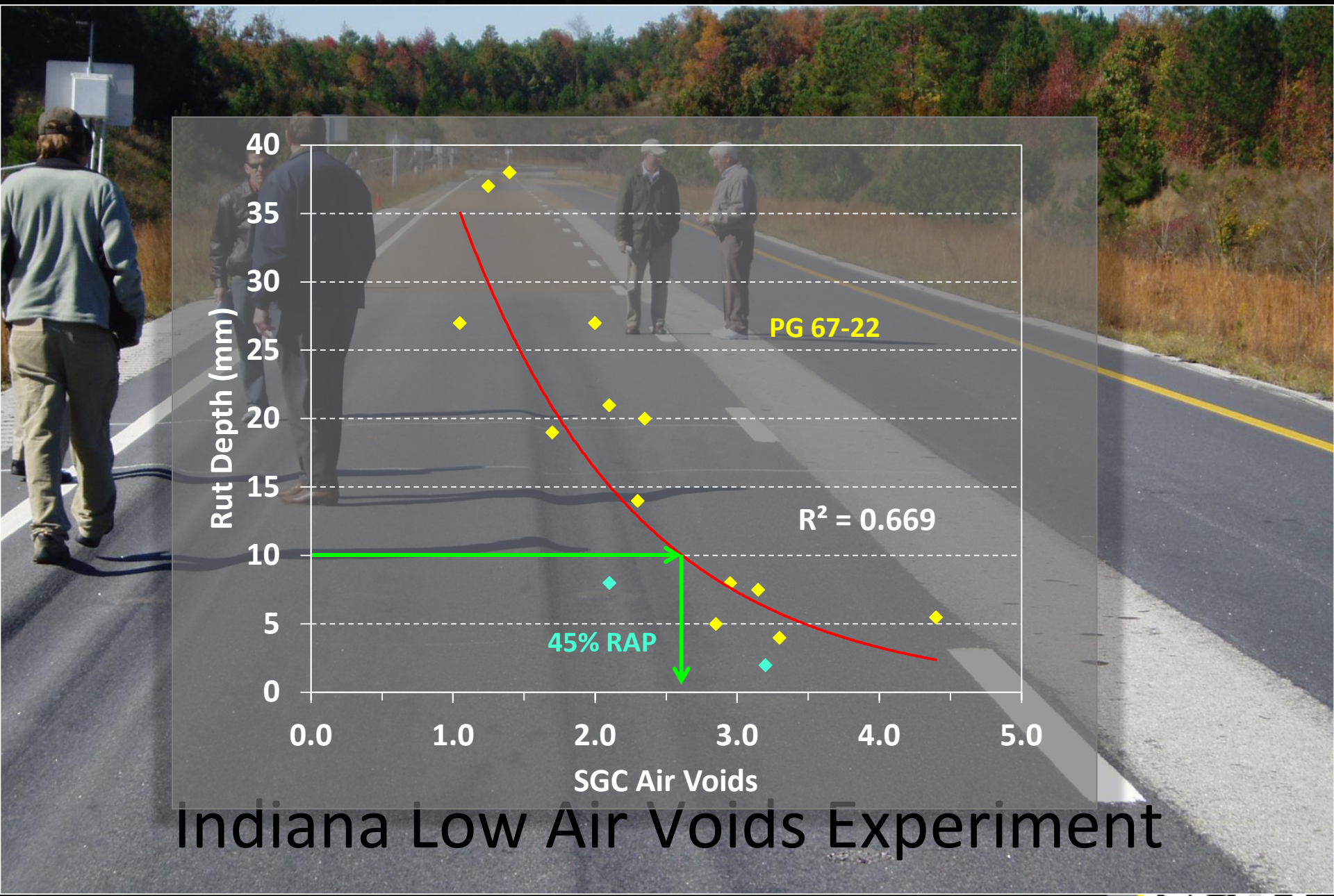

Indiana Low Air Voids Experiment

Structural Analysis

- Revised asphalt layer coefficient for '93 AASHTO Pavement Design
- Mechanistic-Empirical Pavement Design
  - Measured vs. predicted stresses
  - Seasonal effects on asphalt pavement layers
  - Compressive stresses in unbound layers
  - Traffic wander
  - Dual tires vs super-single tire
  - Speed vs strain / load pulse
  - Field fatigue thresholds
  - Calibration of transfer functions

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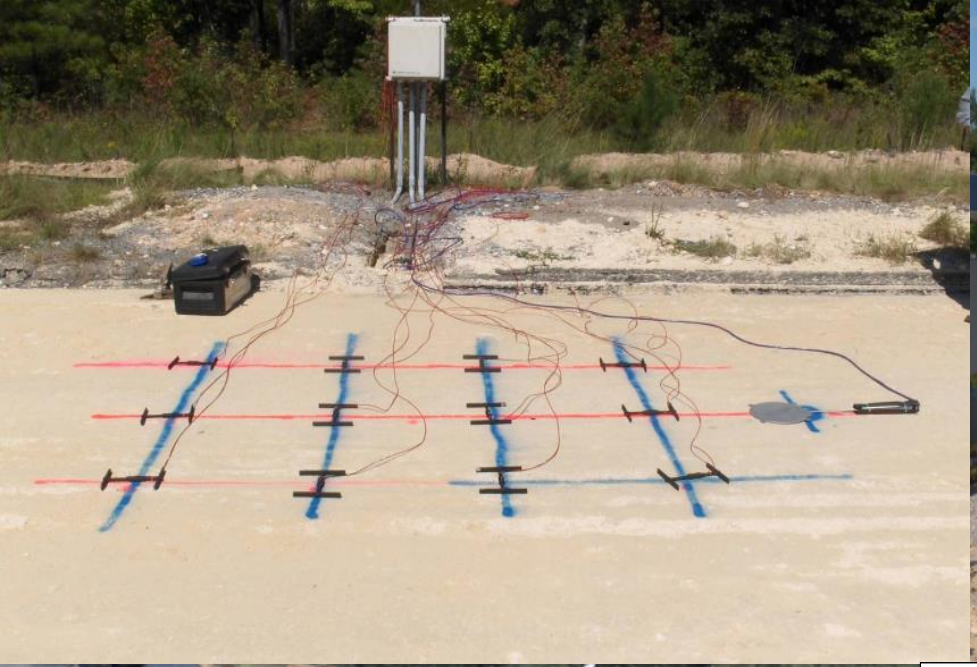
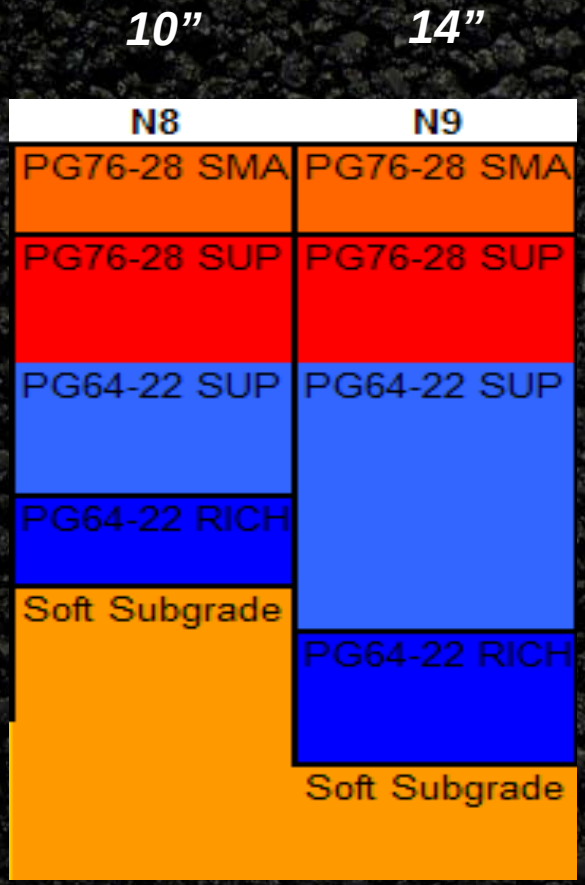
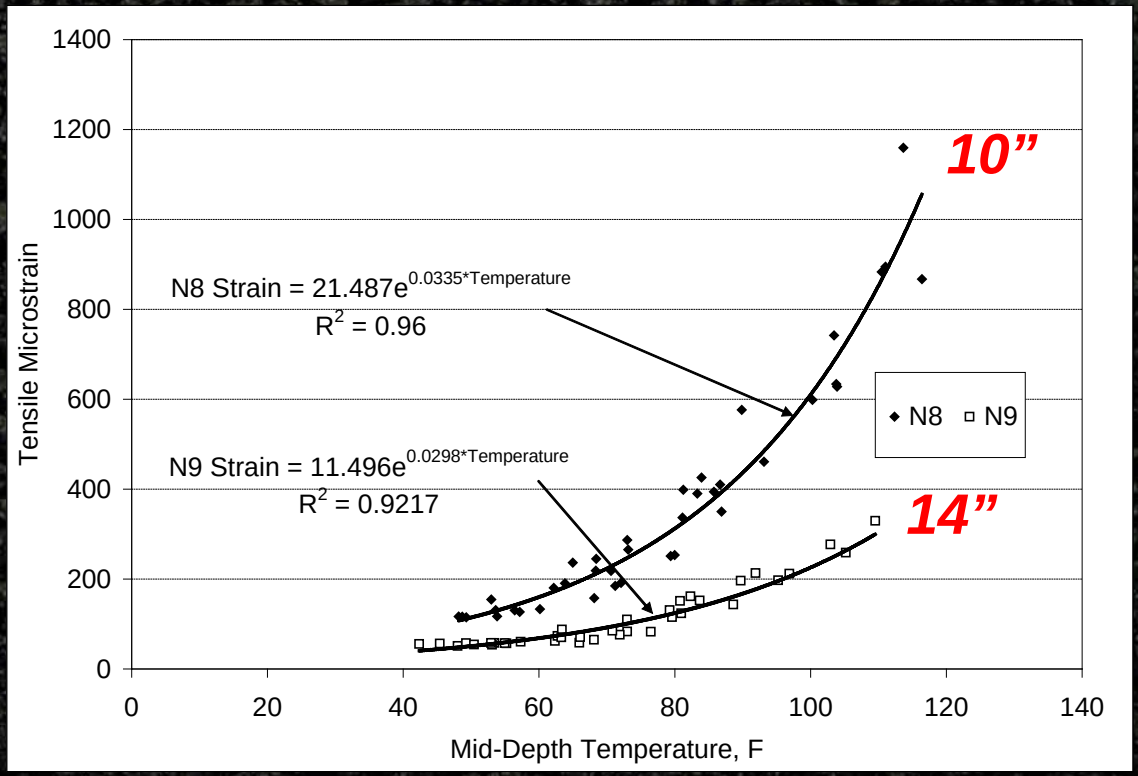



Longtidinal Microstrain
500
400
300
200
100
0
-100
-200
-300
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3
2.5
Time, sec

Oklahoma Perpetual Pavement on a weak subgrade





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Product Evaluations

- WMA
- High polymer mixes
- Asphalt-rubber mixes
- Thiopave
- Trinidad Lake Asphalt
- Fibers
- Dual layer OGFC
- Crack arresting mixes
- High Friction Surface Treatments

Reclaimed Asphalt Pavement

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High RAP Test Sections

- Several experiments with 45 to 50% RAP
  - Surface layers – benefit of using lower PG
  - All layers 50% RAP
    - lower critical strains
    - sections outperformed companion virgin sections
    - essentially a Perpetual Pavement at 7 inches thick

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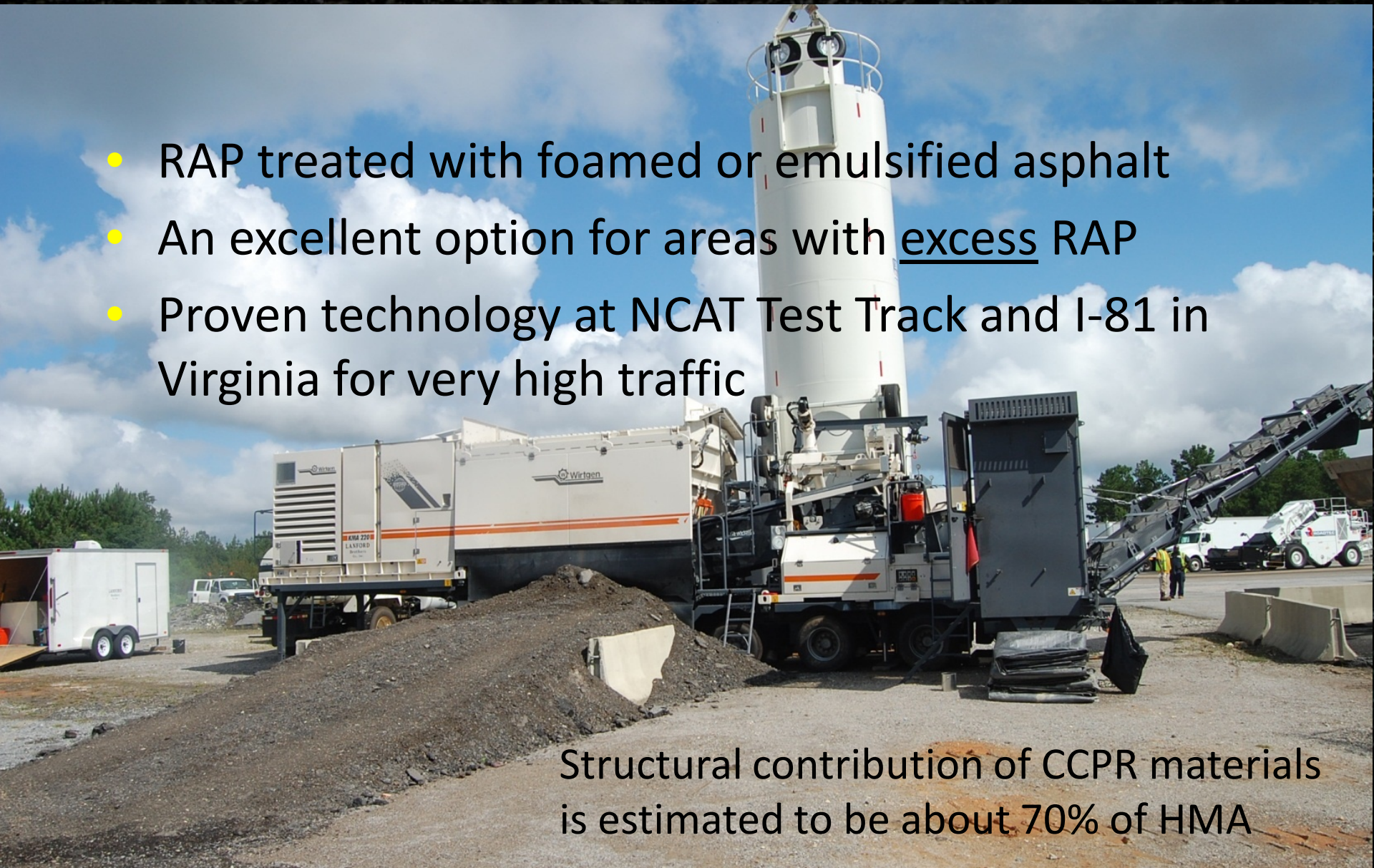
Cold Central Plant Recycling



- RAP treated with foamed or emulsified asphalt
- An excellent option for areas with excess RAP
- Proven technology at NCAT Test Track and I-81 in Virginia for very high traffic

Structural contribution of CCPR materials is estimated to be about 70% of HMA

Cold Central Plant Recycling

- Highly sustainable pavement technology
- Low capital equipment investment

MnROAD + NCAT Partnership

Working together on national need research projects

1. Validating cracking tests for balanced mix design
2. Documenting the life cycle benefits of Pavement Preservation Treatments

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Safer, Smarter, Sustainable Pavements Through Innovative Research

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ADEM
Alabama Department of Environmental Management


ALABAMA
DEPARTMENT OF TRANSPORTATION


COLLABORATIVE
AGGREGATES LLC


CO
CDOT


DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA


FP2


STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION


GDOT
Georgia Department of Transportation


Illinois Department
of Transportation


KENTUCKY
TRANSPORTATION
CABINET


SHA
State Highway
Administration
Maryland Department of Transportation


MDOT
Michigan Department of Transportation


MDOT
MISSISSIPPI DEPARTMENT OF TRANSPORTATION


MINNESOTA
DEPARTMENT OF TRANSPORTATION


MoDOT


NEW YORK
STATE OF
OPPORTUNITY.
Department of
Transportation


STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION


DOT
Oklahoma Department
of Transportation


SCDOT
South Carolina Department of Transportation


TN
TDOT
Department of
Transportation


VDOT
Virginia Department of Transportation


WISCONSIN
DEPARTMENT OF TRANSPORTATION


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With the current volumetric mix design system…

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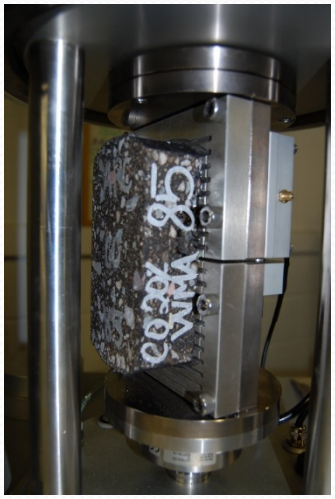
Balanced Mix Design

Cracking Resistance



Rutting Resistance

Scope

NCAT Test Track

- Top-down cracking

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- Low-temperature cracking

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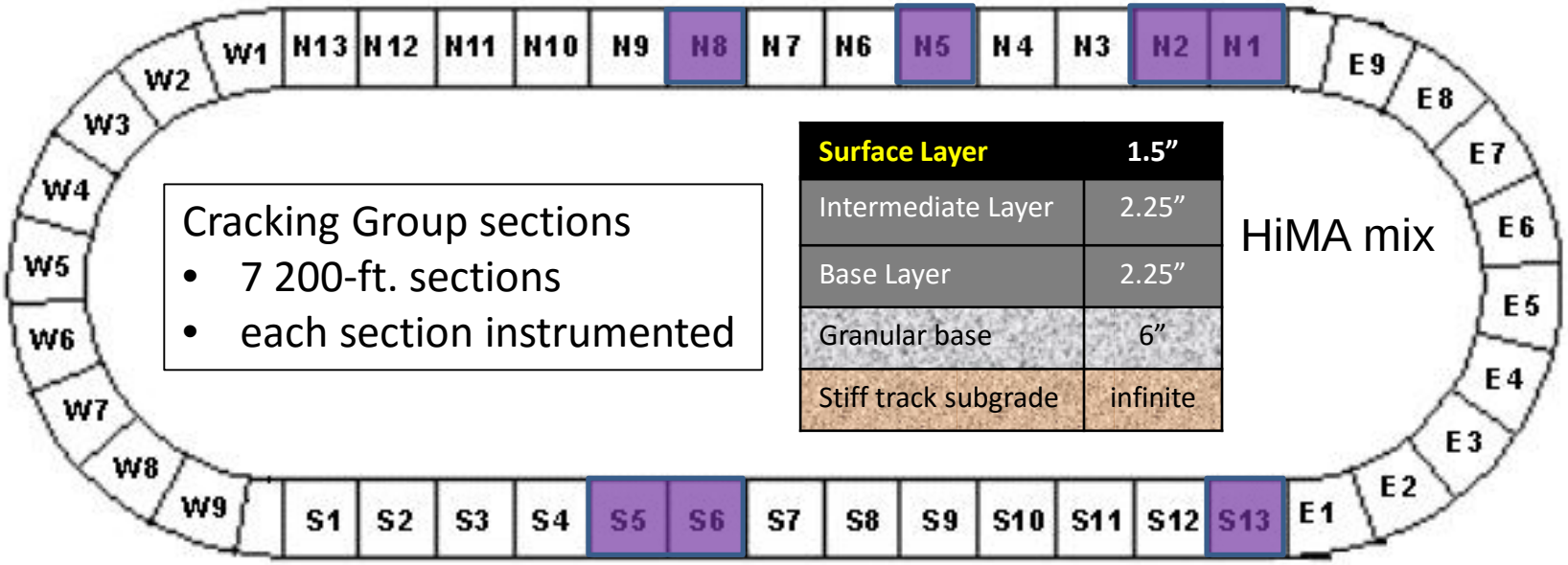
Top-Down Cracking Sections



Cracking Group sections
- 7 200-ft. sections
- each section instrumented

Surface Layer	1.5”
Intermediate Layer	2.25”
Base Layer	2.25”
Granular base	6”
Stiff track subgrade	infinite

HiMA mix

6 million ESALS, 1.5 years, No cracking yet

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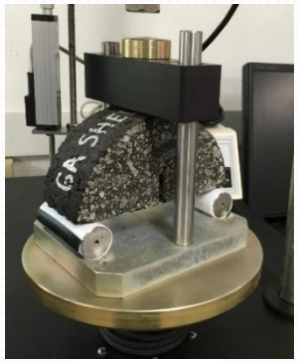
Load Related Asphalt Mixture Cracking Tests

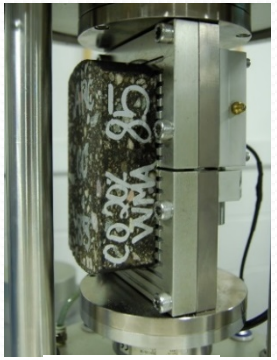
BBF



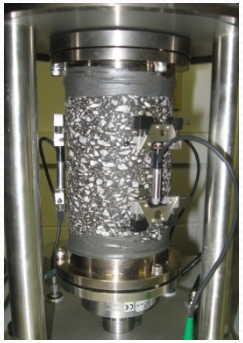
SCB-LA

I-FIT

OT-TX

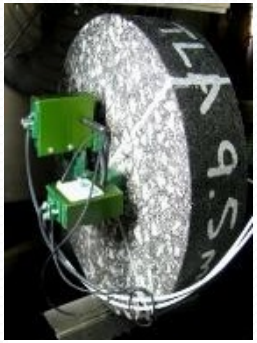


OT-NCAT



SVECD

DCT



Energy Ratio

Nflex Factor

Cantabro

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MnROAD Test Section Layout

Safer, Smarter, Sustainable Pavements Through Innovative Research

MnROAD + NCAT Partnership
Pavement Preservation Experiments

- Warm and cold climates
- Low and high traffic sections
- At least 25 preservation treatment sections on each roadway
- High quality construction
- Performance monitoring

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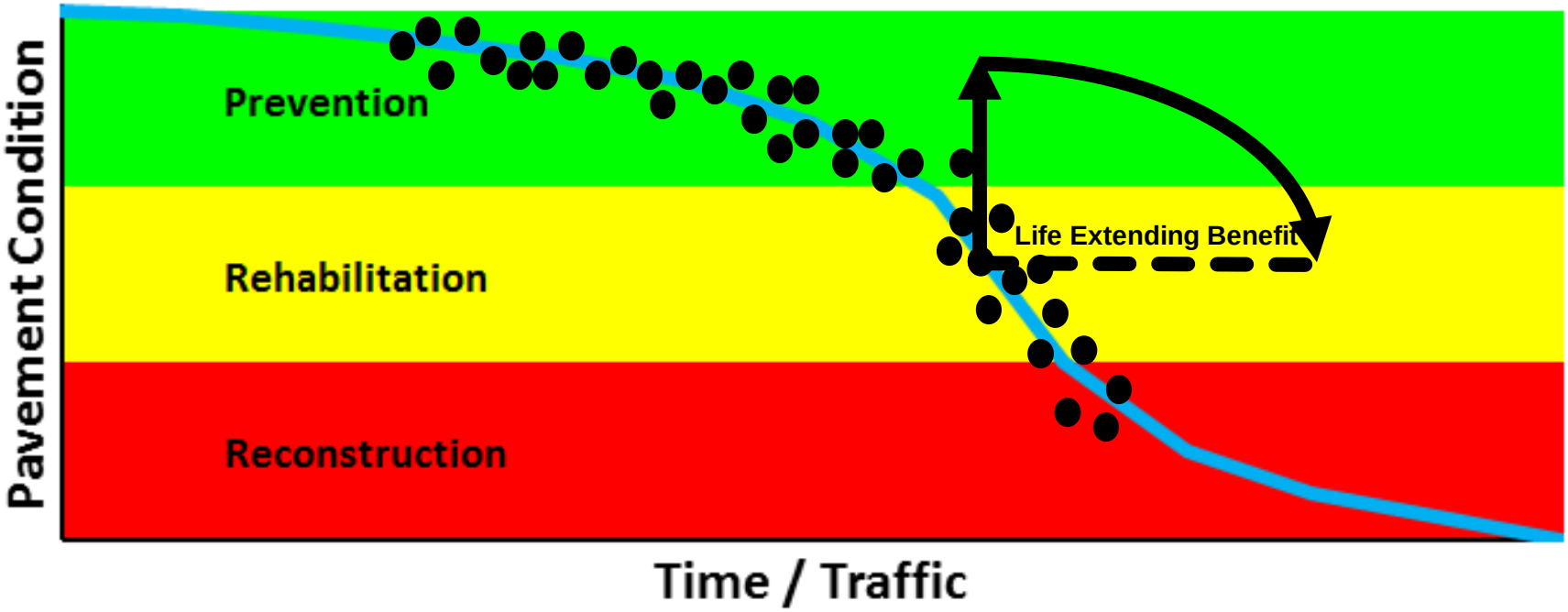
Pavement Preservation



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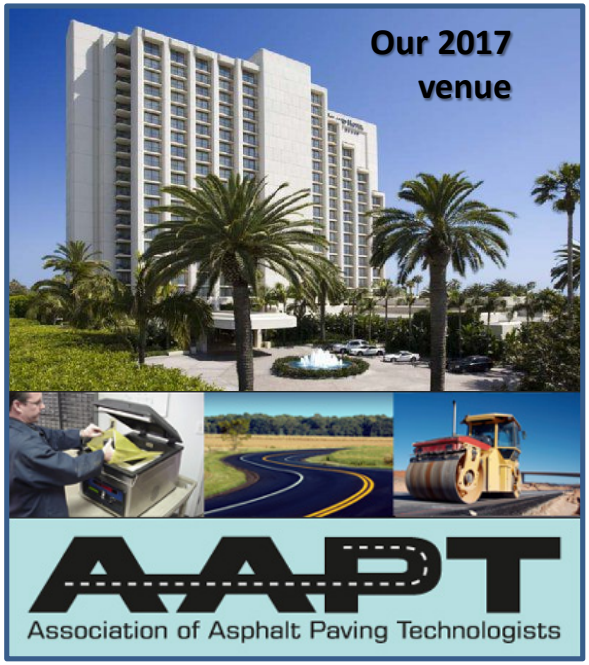
Preservation on Lee County Road 159

Preservation on US 280

Sponsor meeting at MnROAD

92nd AAPT Annual Meeting and Technical Sessions

The 2017 Annual Meeting will be held March 19-22, 2017
The Island Hotel, Newport Beach, California USA



- Leading Edge Workshop, *Practical Implementation of Asphalt Mixture Performance Tests*
- 1st Technical Session, *Pavement Preservation*
- 2nd Technical Session, *Asphalt Mixture Testing*
- AAPT/ISAP International Forum, *Hot Recycling: State of the Art and New Challenges*
- 3rd Technical Session, *Asphalt Binder*
- 4th Technical Session, *Asphalt Mixture*
- Symposium, *Rubberized Asphalt Developments, Opportunities, and Challenges*
- 5th Technical Session, *Recycling*
- 6th Technical Session, *Cracking*

For the latest information please check our web site at: http://www.asphalttechnology.org


Thank You